BASIC SCUBA LESSON 6

OBJECTIVES: By the end of this session the students should be able to discuss:

1. The effects that Boyle's law has on the ***health*** of a diver.	3. The effects that Boyle's law has on ***buoyancy*** while SCUBA Diving.
2. The effects that Boyle's law has on ***air consumption*** (time) at depth.	4. Independent and dependent out of air options.

Boyles Law: as pressure ↑ volume ↓

Effects that Boyle's Law Has on:

Divers Health	Buoyancy	Air Consumption at Depth
1. Squeeze 2. Blocks 3. Pressure injuries: during descent as pressure increases volumes decrease. The greatest change in pressure and volume occurs in the first 33 fsw/34 ffw. 4. Over expansion injuries: during ascents as pressure decreases	1. Wet suit compression 2. Dry suit equalization 3. Buoyancy Compensator 4. Breathing	1. Breathing time decreases with increased depth for a given volume of air. 2. Breathing time at 33fsw is ½ what it would be at the surface 3. Continuing education and SAC rate 4. Which factor has the greatest impact on air consumption? **a. Depth** **b. Activity** c. Temperature

Absolute Pressure = (depth/33') + 1 atm

Depth (ft)	Pressure (atm)	Volume (cu')	Density (psi)	*SAC (1cu'/min)
0'	1	1	X1	80
33'	2	1/2	X2	40
66'	3	1/3	X3	26.7
99'	4	1/4	X4	20
132'	5	1/5	X5	16
165'	6	1/6	X6	13.3

*SAC 37.5psi/min

Out of Air Options

Independent			Dependent	
1. Redundant SCUBA system	2. Emergency Swimming Ascent (40' or less)	3. Emergency Buoyant Ascent (> 40')	4. Octopus Air Sharing	5. Buddy Breathing

SUMMARY:

1. Boyle's law can have a significant effect on the health and safety of a diver. What are a few of the ways that Boyle's law can effect the diver?	3. Boyle's law has an effect on air consumption rate. If all else is held constant how much faster will a tank of air be consumed at 66fsw compared to the surface?
2. Boyle's law can have a significant effect on buoyancy. What are some effects of Boyle's law on buoyancy?	4. A diver should never run out of air but if it should occur, the diver must know how to handle the situation. What are three independent and two dependent out of air actions?

Determining Surface Air Consumption (SAC) Rate

To determine your air consumption rate, use the following procedure.

1. Spend a period of time at a constant depth (or take the average depth of your dive). Let's say **10 minutes** at **20 feet sea water**. During this time, you swim slowly or maintain normal diving activity. After 10 minutes you use **400 psi** of air out of your tank. Divide 400 psi by 10 minutes and your air consumption rate is 40 psi per minute at a depth of 20 feet. **400psi / 10 min = 40 psi/min @ 20 fsw**	2. Express 20 fsw in terms of atmospheres absolute by dividing by 33 fsw and adding 1 atm: **(20 fsw/33 fsw) + 1 atm = 1.6 atm**

3. Next, take your air consumption rate @ 20 fsw (40 psi per minute), and divide by the atmospheric pressure (1.6 atm):

(40 psi/min) / 1.6 atm = 25 psi/min

Surface (SAC Rate) = 25 psi/min x 1 atm = 25 psi/min

At 33 fsw = 25 psi/min x 2 atm = 50 psi/min

At 66 fsw = 25 psi/min x 3 atm = 75 psi/min

Problem One: A diver consumes 200 psi/min at 99 fsw. What is this diver's SAC RATE? **(99 fsw/33 fsw) + 1 atm = 4 atm** **(200 psi/min) / 4 atm = 50 psi/min** **50 psi/min x 1 atm = SAC RATE of 50 psi/min.**	**Problem Two**: Using an 80 cu.ft, 3000 psi cylinder, a diver uses one-third of his air in 15 minutes at a constant depth of 75 feet sea water. What is this diver's SAC RATE? **3000 psi x 1/3 = 1000 psi (air used)** **1000 psi /15 min = 66.6 psi/min (air consumption rate at 75 feet)** **(75 fsw/33 fsw) + 1 atm = 3.27 atm (75 fsw expressed in atmospheres absolute)** **(66.6 psi/min) / 3.27 atm = 20.36 psi/min (SAC RATE)**	**Problem Three**: A diver is planning to dive to a 55 foot depth. She has a 2000 psi fill and her SAC RATE is 17 psi/min. How long will her air last for this dive? **(55 fsw/33 fsw) + 1 atm = 2.66 atm** ***2000 psi - 500 psi = 1500 psi** **17 psi/min x 2.66 atm = 45.22 psi/min** **1500 psi / (45.22 psi/min) = 33.17 minutes**